USAISEC
US Army Information Systems Engineering Command
Fort Huachuca, AZ 85613-5300

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(AIRMICS)

TECHNOLOGY ASSESSMENT OF ISDN

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AIRMICS
115 O'Keefe Building
Georgia Institute of Technology
Atlanta, GA 30332-0800

This research was performed as an in-house project at the Army Institute for Research in Management Information, Communications, and Computer Sciences (AIRMICS), the RDTE organization of the U.S. Army Information Systems Engineering Command (USAISEC). This effort was performed under the AIRMICS Technology Insertion Program to support the U.S. Army Information Systems Command (USAISC) in the development of a report entitled "Long Range Planning Guidance - Objective Configuration." An initial meeting was held in early December in Atlanta to coordinate the task. Twenty-six topics were selected for consideration, with AIRMICS agreeing to conduct technology assessments on fifteen of the topics. Planning Research Corporation (PRC) was assigned responsibility for conducting the remaining assessments and consolidating all the assessments for use in the planning document. In a two-week period, AIRMICS completed the assessments and provided the results to ISC-DCSPLANS and ISEC-SID. This research report is not to be construed as an official Army position, unless so designated by other authorized documents. Material included herein is approved for public release, distribution unlimited. Not protected by copyright laws.

THIS REPORT HAS BEEN REVIEWED AND IS APPROVED

s/ John W. Gowens
John W. Gowens
Division Chief
CNSD

s/ John R. Mitchell
John R. Mitchell
Director
AIRMICS

Integrated Services Digital Network (ISDN)

I. Historical Review

In the past many articles have expounded on ISDN terminology and capabilities, sometimes to the point of confusion. ISDN is an architecture, which, as currently envisioned, provides the same services that are currently available on analog and hybrid switches today. It consolidates these services into a single integrated data-voice-video terminal instead of three or four "devices" currently sitting on your desk.

ISDN is the logical extension of the present day Local Area Networks (LANs) and Wide Area Networks (WANs). It is an attempt by the telecommunications manufactures to define an international standard prior to deployment rather than waiting for a defacto standard to appear. As such, it has the goal of placing all communication protocols and software in the public domain: i.e., not dependent on vendor proprietary products.

In 1984 the International Telegraph and Telephone Consultative Committee (CCITT) Study Group XVIII defined ISDN as:

> *A Network evolved from the telephony Integrated Digital Network (IDN) that provides end-to-end digital connectivity to support a wide variety of services, to which users have access by a limited set of standard multipurpose customer interfaces.*

Thus, ISDN will provide:

- End-to-end digital connectivity (the modem will be obsolete)
- Access and service integration (minimize devices on your desk)
- Customer control of service features (call forwarding/back/etc.)

- Upward compatibility of network features, future expansion
- A limited set of standardized user-network interfaces

Narrowband ISDN has two access rates, basic and primary. (1) Basic access consists of two 64 Kbps B (Bearer) channels plus one 16 kbps D (Data) channel. This is denoted as 2B+D. The B-channels are used for both voice and data, or with some additional electronics, slow-motion video. The D-channel is used for communicating control information and may be used for low speed data. (16 Kbps is 13.3 times faster than a 1200 baud modem.) (2) Primary access is designed to operate on T1 lines in the US. It consists of 23 B+D in North America and Japan at 1.544 megabits per second. (For primary access the D-channel is transmitted at 64 kbps.) Each terminal device will have basic access. Thus, you can talk on your telephone and access a distant data-base with your data terminal, or have 2 separate conversations simultaneously with 2 telephones on the same basic line.

To tie the ISDN network together, the CCITT has recommended several communications protocols to operate at and between the various levels of the Open System Interconnection Reference model. These protocols include:

- X.25, Packet Switched Protocol. X.25 is the CCITT standard that defines the interface between the user Data Terminating Equipment (DTE), a user data device, and the network Data Circuit-Terminating Equipment (DCE), the Carrier's equipment that interfaces with the network. It operates only on Packet Switch (PS) Data on Levels 1 through Level 3, and either B or D-channels. (X. onnects PS Networks together.)

- Q.931, Level 3 Signaling Protocol. The CCITT recommendation specifies: "The layer 3 protocol provides the means to establish, maintain and terminate network connections across an ISDN between communicating applications entities." Q.931 runs on the

D-channel to control the B-channels by providing Call Establishment Messages, Call Information Messages, Call Disestablishment Messages, and Miscellaneous Messages.

- CCS7, Common Channel Signaling #7. CCS7 is a United States standard based on the CCITT Signaling System No. 7. It is a network-to-network (between telephone exchanges) protocol used to separate the signaling path from the voice circuit path on the CS Network. This is sometimes referred to as "out-of-band signaling." CCS provides a savings in bandwidth, provides for network and customer services -- such as 800 service, closed user groups, automatic call redirection, etc., and saves equipment. This is a packet-switching protocol which is sometimes referred to as Signaling System 7 (SS7).

The CCITT will not standardize the basic services that ISDN will provide until the publication of the Blue Book in 1989. When DoD considers ISDN, some DoD specific services required are:

- Multilevel Precedence and Preemption, as in the AUTOVON system
- User Designation of Multiple Satellite Hops (increases flexibility)
- 16 Kbps Clear Channel (useful for end-to-end encryption)
- A standard voice/data work station configuration

All the Regional Holding Companies (RHCs) have announced field trials to learn more about narrowband ISDN. Currently, U.S. Sprint and AT&T are the only long distance carriers which are planning a field trial. With the publication of the CCITT Blue Book in 1989, narrowband ISDN services will initially be available to corporations and governmental agencies, and then to small businesses and homes. The U.S. government is now drawing up plans for a multibillion dollar private ISDN called the Federal Telecommunication System 2000, to provide voice, data, video, and packet- switching services for many government agencies. Current R&D efforts are centering around the technical chal-

lenges of broadband ISDN (which will be fielded shortly after narrowband ISDN in the early 1990's) and user applications.

II. Currently Available

A. CAPABILITY

1. NARROWBAND

Every Regional Bell Operating Company (RBOC) ran beta tests over the past few years to evaluate the emerging narrowband ISDN standards. Many of these tests are now completed and some local RBOCs are offering limited ISDN services to a few selected subscribers. AT&T offers limited long-haul ISDN services at the primary rate between 18 U.S. cities. Currently, Western Europe is 3 to 5 years ahead of the United States on offering ISDN to its subscribers.

2. BROADBAND

Broadband ISDN standards are being defined by the CCITT. Industry and government R&D efforts are following and analyzing the proposed standards. Currently, there are no broadband services available outside the laboratory. Again, Europe is ahead of the U.S. in these efforts.

3. LOCAL LOOP

There is some concern that the harmonic contents of the basic-rate services (up to 1 MegaHz) will cause considerable electromagnetic interference (EMI) at the S and T reference points of nonshielded twisted pair wire. This could be a problem with older installations of twisted pair telephone wire. [1] Southern Bell believes that 90% of their installed local-loops currently meet the noise, line loss, and signal isolation requirements

of ISDN. New York City, however, believes that it has major noise problems at ISDN frequencies over 88% of its local-loops. These problems are further frustrated by crosstalk created principally from Dataphone Digital Services (DDS) and Data over Voice Multiplexed (DVM) services. [2]

B. PRICE/PERFORMANCE/QUALITY

From a user perspective, ISDN is not available. It will be three to five years before it is fully implemented (narrowband). However, ISDN eventually will be widely available, because the survival of the BOCs and long haul companies hinge on widespread customer acceptance of ISDN services. [3] Current commercial efforts are concentrating on the perceived applications of:

- Information sharing/call management: This allows two personal computer users to talk, share screen information, and access an electronic directory.

- Group IV facsimile: This enables users to talk and exchange facsimile over separate B channels on a single ISDN basic-rate interface line.

- Call management/automatic callback: This enables agents to exchange calls and automatically return customer calls when all agents are busy. It can also provide the agent with the calling party's phone number.

- LAN bridging: Allows data to pass between Ethernet local area networks and ISDN long-haul networks.

- Wide-area networking: Similar to LAN bridging, but also allows access to remote personal computers, file servers, and printers.

- Hybrid networks with Primary Rate Interface: This will operate between a user using a private branch exchange and other users using Centrex facilities over an ISDN line.

C. APPLICATION TO THE IMA

Research and development is necessary to determine appropriate applications, configurations, and capabilities of the ISDN architecture to support the IMA.

III. Near Term (1995)

A. CAPABILITY

1. NARROWBAND

CCITT protocol standards, finalized over the past few years, will be readily available from industry to fully field narrowband and begin the beta-testing of broadband ISDN services. Broadband services will be tested on a high speed integrated packet switched network.

ISDN services will replace the need for modems. Although modems will still be available in the home market, industry will go to a total digital interface using ISDN boards in their desktop and portable computers for networking and data transfer.

2. BROADBAND

As fast packet switches are integrated into the network, broadband ISDN will appear within the commercial marketplace and begin to rival the transmission capabilities of the LANs. Broadband will operate on a fiber optic network in the 600 Mbps range compared to the Fiber Data Distributed Interface (FDDI) LANs in the 100 Mbps range. Prototype systems should be available for trials beginning in the 1993 time frame, with deployment starting in the 1995 time frame. Initially broadband will still be relatively expensive compared to LANs, but the associated costs will continue to drop as more are installed. [4]

3. *LOCAL LOOP*

In terms of ISDN replacing LANs, private branch exchanges (PBXs), or other customer-premises equipment, there are several factors to consider. [5]

Functionality

This concerns the organizational issue of public versus private control of the network. ISDN will provide CENTREX services from the local switch. Will users be willing to give up their PBXs and retrograde towards predivestiture by turning over control of their integrated voice and data networks to AT&T and the RBOCs? (This is a management, not a technical question.) Allowing the RBOCs to control the local network will result in less management overhead for the Army, but also less control to reconstitute the network in emergency situations

Transmission Speed

Presently Ethernet claims 10 Mbps and FDDI may provide 100 Mbps, will ISDN be competitive? Actual throughput of these networks is estimated at only 5 to 10 percent of their top-end capability. In Narrowband ISDN there are many applications that will function well in the 64 kbps (B-channel) environment. These include word processing, small file transfer, and buffered graphics ~~(64 Kbps is approximately 8000 bits per second).~~ Applications that involve mass data transfer (computer-to-computer communications, interactive graphics, etc.) will undoubtably be slower via narrowband ISDN than state-of-the-art LANs. However, beta tested broadband ISDN will be competitive.

Replacement of an Established, Proven Base

LANs will be prevalent throughout industry, but broadband ISDN will take a portion of their market. As new systems are installed and existing ones upgraded, broadband ISDN will be able to compete favorably with Ethernet, token ring, and FDDI LANs.

Determining which type to install will center around the management issues discussed above rather than on the technical capabilities of each system. LANs and ISDN will co-exist in the near term with ISDN used as a backbone network interconnecting existing LANs through gateways.

B. PRICE/PERFORMANCE/QUALITY

Costs will continue to drop as ISDN services become widely available. ISDN will be very competitive with similar non-ISDN services, and provide networking capabilities not available before its introduction.

C. APPLICATION TO THE IMA

Military unique requirements will be available from industry for the narrowband initially and then the broadband market. (Many of these protocol requirements are current proposals for incorporation into the American National Standards Institute (ANSI) codes.)

IV. Long Term (2010)

A. CAPABILITY

1. NARROWBAND

Will be replaced by broadband in the commercial and business market place, and possible the home market as well.

2. BROADBAND - Fast Packet Switch

In fast-packet switching, voice, data, signaling, video, and high-speed LAN transfers are combined and piped through a common fiber optic network. The maximum data

rate that a switch node can handle is limited only by the device technology and the delays incurred on longer links. Data rates approaching 100 Mbps (millions of bits per second) can be realized using today's silicon technologies, and several hundred Mbps are feasible using gallium arsenide or submicron NMOS technologies. With superconductive devices, gigabit (billion bit) per second throughputs may be realizable in the 21st century.

This next generation "packet switch" will possess the following characteristics: [6]

- capability for switching high bandwidths measured in the hundreds of Mbps using optical processing and self-routing techniques.
- dynamic bandwidth assignment capabilities to allow a user to "dial up" the amount of bandwidth needed for the occasion.
- nonsymmetric bandwidth capabilities, allowing a user to have differing upstream and downstream channel capabilities as required.
- a very fast switching reconfigurability to allow multiple routing for a multimedia mix of traffic.
- broadcast or multipoint capability for conferencing, narrowcasting, and full-fledged broadcasting.
- increased reliance on distributed intelligence and control technologies.

3. LOCAL LOOP

Broadband ISDN services and performance will surpass the FDDI LANs capabilities on a volume basis. The functionality between the two will merge and their individual identities will become clouded.

B. PRICE/PERFORMANCE/QUALITY

Hardware costs will continue to decrease since standards are well defined and competition between various manufacturers will be intense. The main R&D efforts will be

associated with the development of new applications and the introduction of other advanced networking technologies.

These new technologies will integrate speech into communication systems for controlling computation and describing processes. Video and image processing will be combined with voice and data to increase relevant information availability. ISDN will provide the communication backbone for these new services.

C. APPLICATION TO THE IMA

With the introduction of Fast Packet Switches, video hardware, and fiber optics over the past 10 years, such services as video teleconferencing (VTC) in either a limited conference mode or a broadcast mode will be in wide use. High Definition Television (HDTV) and the transmission medium for distributed systems will be available via broadband ISDN. Such data base services as PRODIGY and AppleLink will be in wide use both in the business world and the home.

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